International Journal of Allied Sciences (IJAS)
Volume.13, Number 6; June-2022;
ISSN: 2836-3760 | Impact Factor: 6.15
https://zapjournals.com/Journals/index.php/Allied-Sciences
Published By: Zendo Academic Publishing

EVALUATING THE EFFECTIVENESS OF WATER-SOLUBLE NPK FOLIAR NUTRITION ON WHEAT (Triticum aestivum L.) YIELD AND PROFITABILITY THROUGH ON-FARM TESTING

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Article Info

Keywords: NPK 19:19:19, On-farm testing, water soluble fertilizer, wheat.

Abstract

In this study, an on-farm testing was carried out on wheat fields in the Kota district during the rabi seasons of 2018-19 and 2019-20 to evaluate the impact of water-soluble NPK foliar sprays on wheat yield and profitability. The technology assessed in this research included the application of recommended doses of fertilizers (RDF-N 120, P 40 & ZnSo4 25 kg ha-1) combined with NPK 19:19:19 foliar sprays at a 0.5% concentration during the tillering and spike initiation stages of wheat growth. A local check was also performed with only the recommended doses of fertilizers, without the NPK foliar sprays. The results of the two-year study showed an 8.30% increase in grain yield when using RDF + two NPK foliar applications compared to the local check (48.99 q/ha). Furthermore, the RDF + NPK foliar sprays led to improvements in yield attributes such as the number of effective tillers (364/m2), the number of grains/ear (42.6), and test weight (45.14) compared to the local check, where these values were found to be 347, 39.5, and 44.03, respectively. The economic analysis revealed that the additional cost of two NPK foliar sprays was Rs. 2960/ha, which resulted in additional returns of Rs. 9403/ha and an IBCR of 3.18.

INTRODUCTION

Wheat (Triticum aestivum L.) is one of the most crucial staple crops worldwide, serving as a primary source of food for over 35% of the global population (Shiferaw et al., 2013). The increasing global population has led to a growing demand for wheat, consequently necessitating improvements in crop productivity to ensure food security (Curtis & Halford, 2014). One potential avenue for enhancing wheat yield and profitability is through the optimization of nutrient management strategies. Among these strategies, foliar nutrition has gained significant attention in recent years due to its potential benefits in terms of crop yield, quality, and overall profitability (Fernández & Brown, 2013). Foliar application of nutrients, especially water-soluble NPK (nitrogen, phosphorus, and potassium) fertilizers, has been reported to improve nutrient uptake efficiency, enhance crop productivity, and mitigate the negative impacts of environmental stress in various crops, including wheat (Eichert & Fernández, 2012; Zörb et al., 2018). The main advantage of foliar nutrition

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over conventional soil-applied fertilizers is that it allows for the direct and rapid absorption of nutrients through the leaf surface, bypassing the constraints imposed by the soil and root system (Fernández et al., 2018). Moreover, foliar nutrition can be tailored to the specific nutrient requirements of the crop at different growth stages, providing a more targeted and efficient approach to nutrient management (Zörb et al., 2018). Despite the growing interest in foliar nutrition for enhancing wheat yield and profitability, there is a need for more comprehensive, on-farm testing to evaluate the effectiveness of water-soluble NPK foliar nutrition in different agroecological zones, management practices, and cultivars. On-farm testing is essential for generating context-specific recommendations that can be directly adopted by farmers to improve their crop management practices and increase their return on investment (Lobell et al., 2015). Furthermore, on-farm testing can help identify the factors that influence the success of foliar nutrition, such as the optimal rates and timings of application, the interactions with other agronomic practices, and the potential trade-offs in terms of environmental sustainability (Tilman et al., 2011). Several studies have reported positive effects of water-soluble NPK foliar nutrition on wheat yield and profitability. For instance, a study by Gupta et al. (2016) found that foliar application of NPK at the tillering and booting stages significantly increased wheat yield, protein content, and net returns compared to the control treatment. Similarly, Amin et al. (2018) reported that foliar application of NPK combined with micronutrients improved wheat yield, grain quality, and profitability under rainfed conditions in Pakistan. These studies provide valuable insights into the potential benefits of foliar nutrition in wheat production; however, more on-farm testing is needed to validate these findings across diverse settings and generate practical recommendations for farmers.

In this study, we aim to evaluate the effectiveness of water-soluble NPK foliar nutrition on wheat yield and profitability through on-farm testing conducted in multiple locations representing different agroecological zones, management practices, and wheat cultivars. We will assess the impact of foliar nutrition on wheat growth, nutrient uptake, grain yield, quality, and net returns, as well as its potential interactions with other agronomic practices such as tillage, irrigation, and pest management. Furthermore, we will investigate the optimal rates and timings of NPK foliar application and their implications for environmental sustainability, considering factors such as nutrient use efficiency, greenhouse gas emissions, and soil health.

By conducting rigorous on-farm testing of water-soluble NPK foliar nutrition in wheat production, our study aims to provide evidence-based recommendations for farmers and policymakers, contribute to the scientific understanding of the factors influencing the success of foliar nutrition, and ultimately help enhance wheat yield and profitability in a sustainable manner.

MATERIALS AND METHODS

An on-farm testing was conducted by KrishiVigyan Kendra Kota during two consecutive *rabi* seasons of 2018-19 and 2019-20 to assess the efficacy of foliar application of water soluble fertilizer NPK 19:19:19 in wheat crop. Sites for the on-farm testing were selected based on the suitability and progressive attitude of the farmers in Charinda, Bagtari and Jorawarpura villages of the Kota district. Kota District falls under Agro-climatic Zone-V “Humid Southeastern plain zone” of Rajasthan. The climate in the district is semi-arid and moderate. Soils of the study area are clay loam in texture with low nitrogen, low to medium phosphorus, high in available potassium and widely deficient in zinc. In present on-farm testing, technology assessed comprised of application of recommended doses of fertilizers (RDF- N 120, P 40 & $ZnSo_4$ 25 kg ha^{-1}) followed by foliar application of water soluble fertilizer NPK 19:19:19

0.5% at tillering and spike initiation stages of wheat crop and performance of this treatment was compared with the plots where only recommended doses of fertilizers (RDF- N 120, P 40 & $ZnSo_4$ 25 kg ha^{-1}) were applied (no sprays of NPK19:19:19). The details of technological options assessed is as below-

T1 = Recommended doses of fertilizers (RDF- N 120, P 40 & $ZnSo_4$ 25 kg ha^{-1})

T2 =RDF + two foliar sprays of NPK (19:19:19) @ 0.5% at tillering and spike initiation

The OFTs were laid out on irrigated fields with soybean-wheat, paddy-wheat and blackgram-wheat rotations which are most prevalent in the area. On selected farmers fields, two plots of 0.16 ha each were made and both the plots were supplied with recommended doses of fertilizers (N 120 kg & P 40 kg ha^{-1}). Soil application of zinc sulphate @ 25 kg ha^{-1} was done at the time of last ploughing in Zn deficient fields as common treatment. Half of the recommended N dose and full dose of P fertilizer were applied as basal and remaining half dose of N was applied at the time of first irrigation (20-25 DAS). In one of the two such RDF applied plots, two foliar sprays of NPK 19:19:19 @ 0.5% were applied at two growth stages, first at tillering (45-50 DAS) and second at spike initiation stage (65-70 DAS) with a spray volume of 600 litres ha^{-1}. Another plot was kept unsprayed plot of NPK (local check). Wheat varieties Raj-4079 and Raj-4037 were used under irrigated timely sown farming situation. Each treatment was replicated on six farmer field's during 2018-19 and on ten farmer fields in 2019-20. Beside one set of OFT was also laidout at KVK, Kota farm. The sowing was done during November month by drilling in 22.5 cm rows apart using seed rate of 100-120 kg $ha^{-1}$and applied 3 to 4 irrigations at critical growth stages of the crop. Harvesting of crop was done during first fortnight of April. Data related to yield, yield attributes and cost particulars were collected separately for the foliar applied and local check plot. At physiological maturity, number of effective tillers (ear bearing shoots) were counted non-destructively from randomly selected one m^2 area in each plot. Randomly selected ten ears from each plots were threshed and grains were counted for determining the average number of grains ear^{-1}. The grain samples were drawn from the produce of each plot while weighing the net plot yield. Thousand grains were counted from each of selected grain samples and weighed on an electric top pan balance to workout test weight (g). The average prices of inputs and outputs commodities prevailed during each year were taken for calculating cost of cultivation, net return and benefit cost ratio.

RESULTS AND DISCUSSION

Yield and yield attributes: Data presented on yield and yield attributes (table.1) clearly reveals that RDF+ foliar application of NPK 19:19:19 recorded substantially higher grain yield over local check (RDF only)) during both the years of on-farm assessment. Two foliar sprays of NPK (19:19:19) @ 0.5% at tillering& spike initiation stages in wheat crop recorded 7.65 and 8.98 percent increase in grain yield over local check during 2018-19 and 2019-20; respectively. On pooled basis, 53.06 qha^{-1} grain yield was recorded under foliar NPK 19:19:19 applied plots which represents 8.30 per cent yield enhancement over local check (48.99 q ha^{-1}). A perusal of data on yield attributes indicated positive influence of NPK19:19:19 foliar nutrition on no. of effective tillers m^{-2}, no. of grains ear^{-1} and test weight (g) over local check. On pooled basis, foliar application of NPK 19:19:19 shows 3.70, 7.84 and 2.52 per cent increase in no. of effective tillers m^{-2}, no. of grains ear^{-1} and test weight; respectively. However, the increase in these yield attributes were marginal and needs further research validation. Foliar application of nutrients along with recommended dose of fertilizers increased the yield components due to foliar spray as it facilitates the higher photosynthetic translocation to sink by increasing the photosynthesizing area and its capacity of particular crop (Thakur et al., 2017). Yield enhancement in wheat due to foliar application of NPK 19:19:19 on farmer fields was also reported by Sharma (2016).

Table.1 Effect of foliar sprays of NPK 19:19:19 on yield attributes and yield of wheat

Technological options	No. of effective tillers m^{-2}			No. of Grains ear^{-1}			Test weight (g)			Grain yield (q ha^{-1})		
	Y1	Y2	P	Y1	Y2	P	Y1	Y2	P	Y1	Y2	P
T1	343	351	347	38.5	40.5	39.5	43.86	44.20	44.03	49.12	48.85	48.99
T2	358	369	364	41.2	43.9	42.6	44.93	45.35	45.14	52.88	53.24	53.06

Y1- 2018-19 Y2- 2019-20 P- Pooled mean

Economic returns: Based on average prices of inputs and output commodities prevailed during each year of assessment, values of economic indicators i.e. gross cost of cultivation, gross returns, net returns and B:C ratio are presented in table 2. Economic analysis clearly reveals that foliar application of water soluble NPK in wheat provided higher net returns over local check during both the years. This treatment fetched average net returns of Rs. 67554 ha^{1} which represents 10.24 increase over local check (Rs. 61112 ha^{-1}). Additional cost of foliar Application of NPK worked out to be Rs.2900 and 3020 ha^{-1}which in turn provided additional returns of Rs. 9026 and 9779 ha^{-1} during 2018-19 and 2019-20; respectively. On pooled basis, foliar treatment provided additional returns of Rs.9403 ha^{-1} with additional cost of only Rs.2960 ha^{-1} and IBCR of 3.18. Overall B: C ratio were also found higher in foliar applied treatment over local check which clearly indicates that foliar application of water soluble

NPK in wheat might be economically feasible and profitable techniques on farmer's fields. Sharma (2016) also reported NPK 19:19:19 to be economical at farmers' fields in Rajasthan.

Farmers were also found highly convinced with the technological interventions due to higher economic returns with least additional investment and management practices. The variation in cost benefit ratio during different years might be due to variation in yield performance and input output cost in that particular year.

Table.2 Economic analysis of foliar sprays of NPK 19:19:19 in wheat

Particulars	**2018-19**		**2019-20**		**Average**	
	T1	**T2**	**T1**	**T2**	**T1**	**T2**
Gross cost (Rs. /ha)	30555	33455	31650	34670	31103	34063
Gross Returns (Rs./ha)	90389	99414	94039	103818	92214	101616
Net Returns (Rs.ha)	59834	65959	62389	69148	61112	67554
B:C Ratio	2.96	2.97	2.97	2.99	2.97	2.98
Additional cost of foliar sprays (Rs./ha)	-	2900	-	3020	-	2960
Additional returns due to foliar sprays(Rs./ha)	-	9026	-	9779	-	9403
Incremental Benefit Cost Ratio (IBCR)	-	3.11	-	3.24	-	3.18

CONCLUSION

Based on the result of present investigation, it may be concluded that foliar application of water soluble NPK 19:19:19@ 0.5% at tillering and spike initiation stages in wheat along with recommended doses of fertilizer found to be yield remunerative and economically viable nutrient management option on farmers fields under irrigated farming situation of Kota district in Rajasthan. Research on foliar nutrition of one or more nutrients to supplement soil application of fertilizers may be strengthen to enhance the yield advantage.

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